



Recent (and upcoming) Testing Results

Lighting product testing efforts

- National Lighting Product Information Program (NLPIP)
- Program for the Analysis and Evaluation of Residential Lighting (PEARL)
- ENERGY STAR® “Durability” testing
- Field Test DELTA (Design and Evaluation of Lighting Technologies and Applications)
- Ongoing testing (time permitting)

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National Lighting Product Information Program (NLPIP)

- Tests lighting products and publishes results for public use: <http://www.lrc.rpi.edu/nlPIP/>
- Research efforts directed by Sponsors
 - California Energy Commission
 - Iowa Energy Center
 - Lighting Research Center
 - New York State Energy Research and Development Authority
 - Northwest Energy Efficiency Alliance
 - US Department of Energy
 - US Environmental Protection Agency
 - Wisconsin Focus on Energy



NLPIP - Project Updates

- Specifier Reports – online databases
 - Screwbase CFLs
 - Electronic Ballasts
- Lighting Answers
 - Mid-wattage metal halide lamps
 - MR16s
 - T5 Systems
- Ongoing Research (will discuss, time permitting)
 - SCFLs
 - Instant-start systems
 - Pulse-start metal halide lumen maintenance

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Online supplement: SCFLs

NATIONAL LIGHTING PRODUCT INFORMATION PROGRAM

Database Search: Screwbase Compact Fluorescent Lamps
(NLPIP Test Data)
Last Updated December 2002

Manufacturer:

Catalog Number:

Ballast Form: ☐ Self-Ballasted ☐ Modular

Ballast Type: ☐ Electronic ☐ Magnetic

Data Measured with Lamp in Base-Up Position

Active Power: Between and watts

Power Factor: Between and WVA

Current THD: Between and %

Light Output: Between and lumens

Data Measured with Lamp in Base-Down Position

Active Power: Between and watts

Power Factor: Between and WVA

Current THD: Between and %

<http://www.lrc.rpi.edu/nlpip/default.cfm>

Online supplement: SCFLs

- Manufacturer name, model number
- Active Power (W) in Base-Up and Base-Down Positions
- Power Factor (W/VA) in Base-Up and Base-Down Positions
- Current THD (%) in Base-Up and Base-Down Positions
- Light Output (lm) in Base-Up and Base-Down Positions
- Position Factor ($\text{Base-Down} \div \text{Base-Up Light Output}$)

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Online supplement: Electronic Ballasts

NLPIP - Electronic Ballast Database - Microsoft Internet Explorer

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Address <http://www.lrc.rpi.edu/nlpip/Eballast/1.cfm> Go Links

NLPIP
NATIONAL LIGHTING PRODUCT INFORMATION PROGRAM

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SEARCH

Specifier Report: [Electronic Ballasts \(2000\)](#) is the NLPIP report that accompanies this database. It explains ballast technology and application considerations, and describes the methods used to gather this data. The report is free in Adobe Acrobat format and can be downloaded from the [NLPIP Publications page](#).

Electronic Ballasts Database

Specify Your Search Criteria:

Number of Lamps:

Lamp Type:

Voltage: ☒ 120 ☐ 277 ☐ 347 ☐ Any

Manufacturer:

Show tested products only:

Select Data Columns to Display:

Columns marked with an asterisk (*) were tested by NLPIP.

1.
2.
3.
4.
5.
6.
7.

Select Sort Criteria:

Start Search... Lightin... Micros... Inbox ... 2003 ... NEEP... NLPIP... NLPIP... Internet

11:19 AM

Online supplement (T8 ballasts)

NLPIP measures:

- Operating parameters: power (W), power factor, current THD (%), lamp CCF, and lamp operating frequency
- Starting parameters: Rh/Rc (for rapid start and programmed start ballasts)
- Performance evaluation: ballast factor and ballast efficacy factor (%/W)

Other upcoming online supplements

Jan/03-Jun/03: Complete testing 64 T8-ballasts
and post online

Jul/03-Dec/03: Test dimming ballasts

Jan/04-Jun/04: T5 ballast supplementary test

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Lighting Answers: Mid-wattage Metal Halide Lamps

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NLPIP Lighting Answers

Volume 7 Issue 1 January 2003

Mid-wattage Metal Halide Lamps

Abstract

This publication answers commonly asked questions about mid-wattage metal halide lamps. *Lighting Answers: Mid-wattage Metal Halide Lamps* helps lighting professionals understand what mid-wattage metal halide lamps are and their most important performance characteristics. It explains the how the lamps work, the differences between quartz and ceramic arc tubes, and the differences between probe-start and pulse-start technologies. It provides information about issues such as burning position and warm-up and restrike times. Finally, this publication provides pointers to lighting professionals on how to choose mid-wattage metal halide lamps for their applications.

Introduction

Metal halide (MH) lamps are available in low, mid-range, and high wattages from 35 to 2000 watts. Mid-wattage MH lamps are those ranging from 175 to 400 watts. All major lamp manufacturers offer MH lamps in this range, commonly in wattages of 175, 200, 225, 250, 300, 320, 350, 360, and 400 watts.

MH lamps are a type of **high-intensity discharge (HID)** lamp that offers long **life**, high **efficacy**, and good color rendering properties. In general, they are energy efficient, produce less heat than incandescent lamps, and allow for good optical control. These qualities make them attractive for applications such as retail establishments, where both low operating cost and good light quality are important. Because of their long life, MH lamps are also appropriate for buildings with high ceilings and other facilities in which lighting is constantly in use for many hours at a time. They are popular choices for high-bay and low-bay industrial operations, warehouses, street lighting, and stadium and sports lighting. Like other **discharge lamps**, all MH lamps require a **ballast** to operate. (See ["Why do metal halide lamps require a ballast?"](#))

MH lamps provide white light in a variety of **correlated color temperatures (CCTs)** ranging from 3000 to 5000 kelvins, and are commonly available with a **color rendering index (CRI)** of 65 to 70, but can also have a CRI of 90 or above. They are superior in color characteristic to most **high-pressure sodium (HPS)** and mercury vapor lamps that have lower CRI values and can produce only a limited range of light colors.

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[Technical Details](#)

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NLPIP | Lighting Answers | Mid-Wattage Metal Halide | - Microsoft Internet Explorer

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Address http://www.lrc.rpi.edu/nlpip/mwhl/differenceQuartzCeramic.asp

Volume 7 Issue 1 January 2003

Mid-wattage Metal Halide Lamps

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What is the difference between quartz and ceramic arc tubes?

Metal halide (MH) lamp **arc tubes** are made of either quartz or ceramic (see Figure 1). Ceramic arc tubes allow higher arc tube temperatures, which manufacturers claim results in better **efficacy**, color rendering, and color stability. Currently, lamps with ceramic arc tubes are available mainly in wattages below 150 watts. Mid-wattage ceramic MH lamps are only beginning to make their way onto the market. Only one manufacturer offers this product, which is also a pulse-start technology. (See ["What is the difference between probe-start and pulse-start?"](#))

Figure 1. Arc tube construction

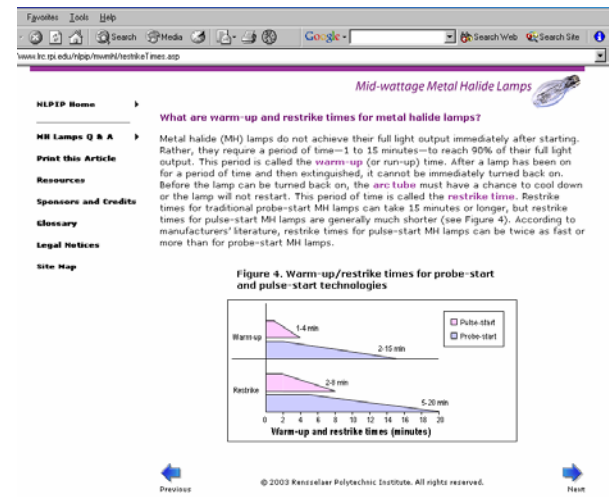
Probe-start arc tubes

Pulse-start arc tubes

<http://www.lrc.rpi.edu/nlpip/results.cfm?uid=882&title=Mid%2Dwattage%20Metal%20Halide%20Lamps>

Lighting Answers: Mid-wattage Metal Halide Lamps

- Answers commonly asked questions
- Helps lighting professionals understand the technology
 - how the lamps work
 - differences between quartz and ceramic arc tubes
 - differences between probe-start and pulse-start technologies
 - burning position
 - warm-up and restrike times
- How to choose mid-wattage metal halide lamps for applications



NLPIP - Project Updates

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Lighting Answers: MR16s

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NLPIP Lighting Answers

Volume 6 Issue 2 September 2002

MR16 Lamps

What are MR16 lamps?

MR16 stands for multifaceted reflector, a pressed glass reflector with the inside (reflecting side) surface composed of facets and covered by a reflective coating. These facets provide optical control by gathering the light from the filament to create a concentrated beam of light. The reflectors of some MR lamps have a smooth inside surface instead of facets, but they are still called MR lamps by convention. Figure 2-1 shows MR16 lamps with different reflector types.

Figure 2-1. MR16 lamps with different reflector designs *



*Enclosed is an A-lamp on the right shown for size comparison.

Did YOU know?

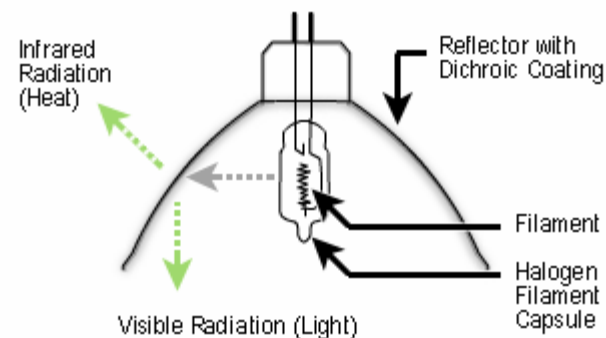
The light source of MR lamps is a single-ended quartz **halogen** filament capsule. The reflective coating of MR16 lamps can be either dichroic or aluminum. A dichroic coating is a thin, multi-layer dielectric (non-metallic film) that allows infrared radiation (heat) from the filament capsule to pass through the reflector while it reflects visible radiation (light) forward (see Figure 2-2). An aluminum coating is a thin film of aluminum that, unlike the dichroic coating, reflects both infrared and visible radiation. Some MR16 lamps have a cover glass on the front end of the reflector. This cover is a safety measure designed to contain any broken fragments in case the lamp shatters when it falls (see "What are the disadvantages of MR16 lamps?").

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Figure 2-2. Schematic diagram of how a dichroic coating works



Did YOU know?

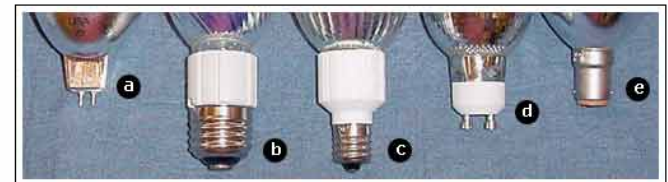
MR lamps come in different sizes. The size is determined by the maximum diameter in eighth-of-an-inch increments (1 inch equals 2.5 centimeters). The most common MR lamp, the MR16, is 16 eighths of an inch or 2 inches (5 centimeters) in diameter at its largest circumference, hence the name "MR16." Other sizes include MR11 (1-3/8 inch, or 3.5 centimeters in diameter) and MR8 (1 inch, or 2.5 centimeters in diameter). The power ratings of MR16 lamps used in architectural lighting applications range from 35 to 100 watts.

<http://www.lrc.rpi.edu/nlpip/results.cfm?uid=285&title=MR16%20Lamps>

Lighting Answers: MR16

- Answers commonly asked questions
- Helps lighting professionals understand
 - what MR16 lamps are
 - most important performance characteristics
 - advantages and disadvantages
 - differences between MR16 lamps and other types of reflector lamps
 - heat and quality differences
- provides pointers to lighting professionals on how to choose MR16 lamps for their applications

Figure 2-3. Different MR16 lamp base types



- (a) 2-pin
- (b) medium screwbase with integral transformer
- (c) intermediate screwbase with integral transformer
- (d) turn and lock
- (e) bayonet

MR16 Advantages



Figure 3-2. Illuminances (lux) on and around the painting from a reflector CFL and an MR16 lamp

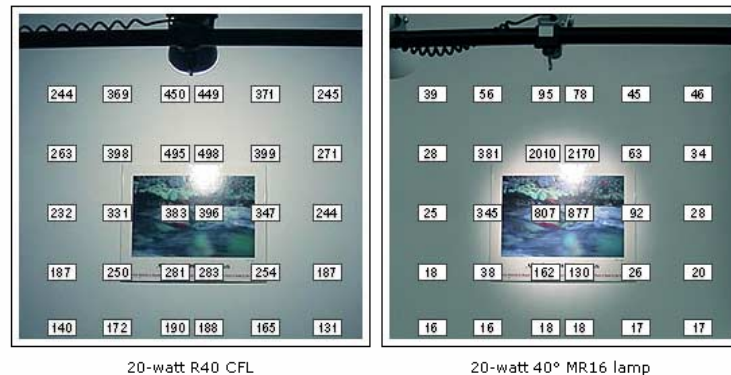
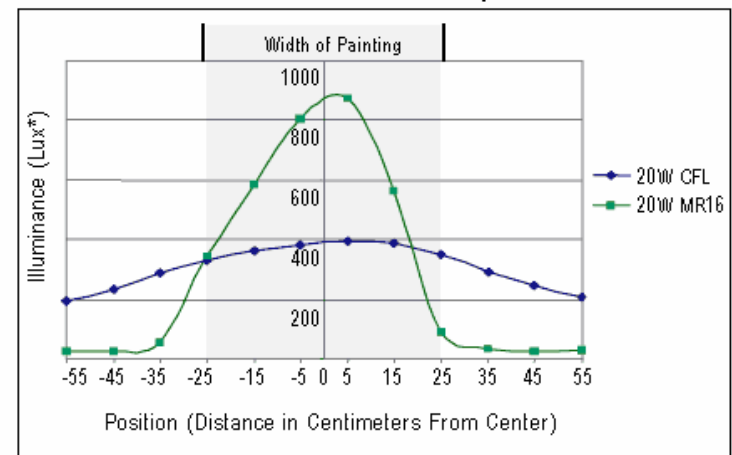


Figure 3-3. Horizontal centerline illuminance plot of a reflector CFL and an MR16 lamp



*1 lux = 0.0929 footcandles

20-watt R40 CFL vs. 20-watt 40° MR16 lamp

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Lighting Answers: T5 Systems

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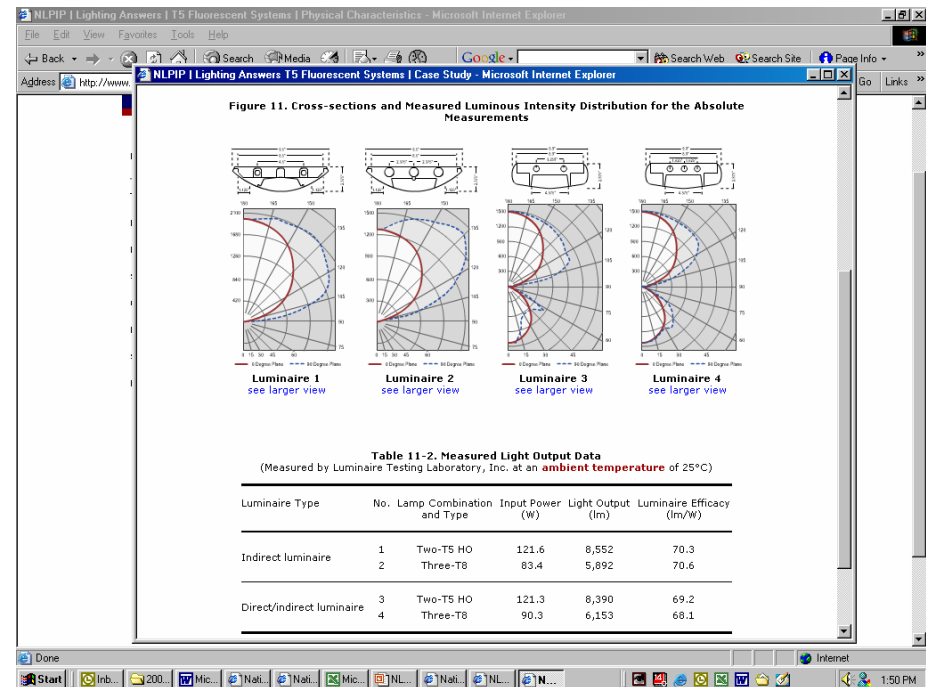
This publication answers commonly asked questions about T5 systems, including T5 lamps, ballasts, and luminaires. Lighting Answers: T5 Fluorescent Systems contains three parts: physical characteristics, economic issues, and design and applications. The first section, physical characteristics, addresses questions on dimensions and performance of lamps, ballast, and luminaire performance. The second section, economic issues, focuses on the monetary benefits of T5 systems. The third section, design and application, discusses proper applications of T5 lamps and the advantages and disadvantages of T5 systems versus T8 systems in lighting design.

Introduction

The T5 lamp is an increasingly popular development in fluorescent lighting. In 1995, T5 fluorescent lamps entered the market in the United States. Today, the three major lamp manufacturers aggressively market T5 lamps. Luminaire manufacturers create innovatively designed compact luminaires using up-to-date optical materials. Recently, lighting designers have begun to specify such T5 luminaires for high-and new construction. The marketing and innovative design of T5 systems have left many end users wondering whether they should consider T5 luminaires instead of T8 luminaires, especially in new construction and retrofitting of T12 magnetic systems, and users are confused by the 10% (50%) difference in optimal temperature and the small difference in **system efficacy** between T5 and T8 systems. This section focuses on physical characteristics of T5 systems compared to T8 systems. This publication discusses T5 systems—including T5 lamps, ballasts, and luminaires—to answer commonly asked questions.

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<http://www.lrc.rpi.edu/nlPIP/results.cfm?uid=284&title=T5%20Fluorescent%20Systems>

Lighting Answers: T5 Systems

- Answers commonly asked questions about T5 lamps, ballasts, and luminaires
- physical characteristics
 - dimensions of lamps and ballast
 - luminaire performance
- economic issues - benefits of T5 systems
- design and application
 - proper applications of T5 lamps
 - advantages and disadvantages of T5 vs. T8 systems

Lighting Answers: T5 Systems

“Case study” results

- Temperatures – in open luminaires, possibly less than optimal temperature for T5; in closed luminaires, T5 may function better than T8
- Greater optical efficiency – fewer luminaires can be used
- Light output comparisons – lm/W equivalent with T8, but fewer luminaires could be used
- Economic comparisons – if layout permits reduced number of luminaires, T5 uplighting can offer advantage
- Glare concerns – $T5_{HO} = 3 \times$ luminance of T8

Lighting product testing efforts

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- **Program for the Analysis and Evaluation of Residential Lighting (PEARL)**
- ENERGY STAR® “Durability” testing
- Field Test DELTA (Design and Evaluation of Lighting Technologies and Applications)
- Ongoing testing (time permitting)

Program for the Analysis and Evaluation of Residential Lighting (PEARL)

- Watchdog program
- Tests ENERGY STAR luminaires and CFLs that are promoted by market transformation groups
- Data used internally by PEARL sponsors and eventually US DOE and US EPA
- Supported and directed by
 - Utilities
 - Public benefits funding agencies

Program for for the Analysis and Evaluation of Residential Lighting (PEARL)

- 3 cycles completed as of December 2002
- 20 CFL products and 10 fixture products are selected per cycle
- Results
 - Some products delisted
 - Some products improved

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ENERGY STAR® “Durability” Testing

- Steele (2002) showed premature failures in ENERGY STAR lighting products
- Premature failures give poor impression to all ENERGY STAR products (copiers, monitors, etc)
- US EPA wants to develop testing procedure to reduce premature failures
- “Durability” testing placeholder in current spec

ENERGY STAR® “Durability” Testing

Goals:

- Develop a simple testing method for "durability" to reduce likelihood of premature failures of ENERGY STAR light fixtures
- Build industry consensus on proposed testing method
- Perform pilot testing to fine-tune proposed testing method
- <http://www.lrc.rpi.edu/ltgtrans/energyStarDurability.html>

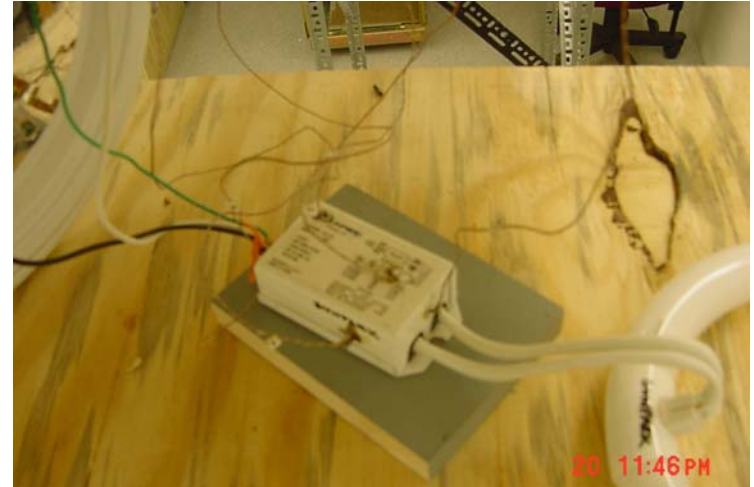
ENERGY STAR® “Durability” Testing

- Consulted other researchers (PNNL)
- Industry roundtable



ENERGY STAR® “Durability” Testing

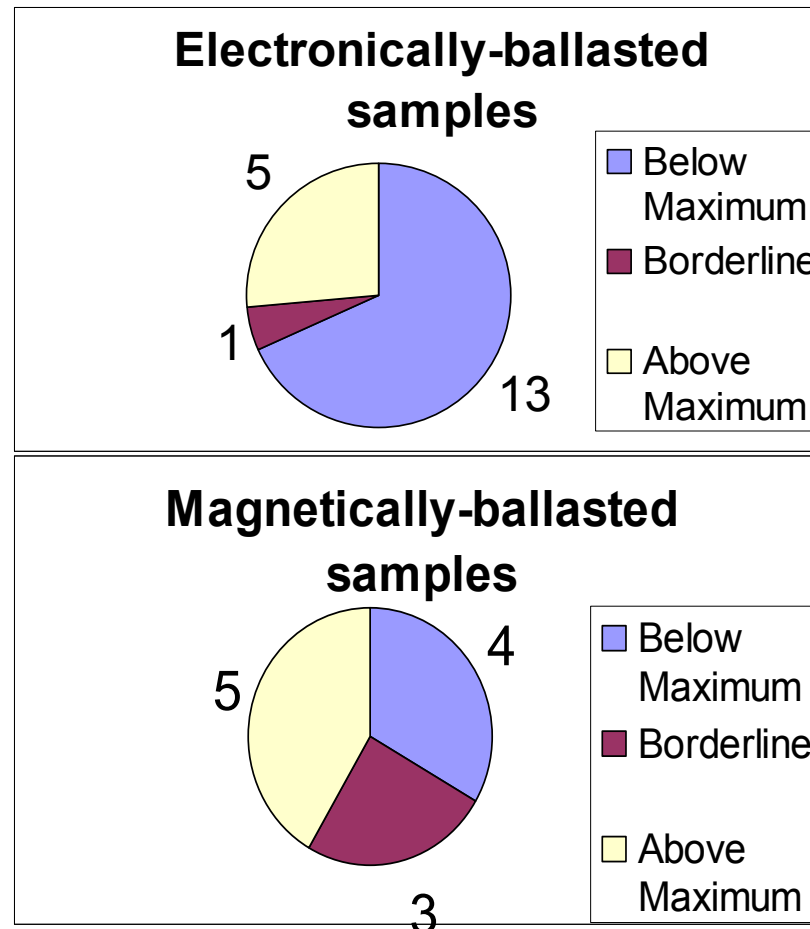
- Focused on temperature of ballast
 - Critical locations, as per ballast mfr
 - Compare rated temp to actual conditions
- Used UL apparatus and procedure



ENERGY STAR® “Durability” Testing



ENERGY STAR® “Durability” Testing



Caveat: Maximum allowable temperatures... performance-based or safety-based?

ENERGY STAR® “Durability” Testing

- Temperature measurement will be proposed
 - UL exemption issue
- Other follow-up work
 - Stress testing
 - Under- and over-voltage

Lighting product testing efforts

- National Lighting Product Information Program (NLPIP)
- Program for the Analysis and Evaluation of Residential Lighting (PEARL)
- ENERGY STAR® “Durability” testing
- **Field Test DELTA (Design and Evaluation of Lighting Technologies and Applications)**
- Ongoing testing (time permitting)

Field Test DELTA

- Helps lighting manufacturers evaluate products before widespread commercialization
- If poor results, identify improvement opportunities
- If positive results, publish case study
 - Product description
 - Field test site
 - Methodology
 - Occupant feedback
 - Performance of product
 - Energy savings
 - Recommendations



Demonstration and Evaluation of Lighting Technologies and Applications

Field Test DELTA - Skylight

- Installed four units in CT warehouse
- Significant energy savings, despite long hours of operation
- Occupants appreciated connection to exterior
- Commercialization underway

Before installation



After — Nighttime



After — Daytime with ISL electric lighting on

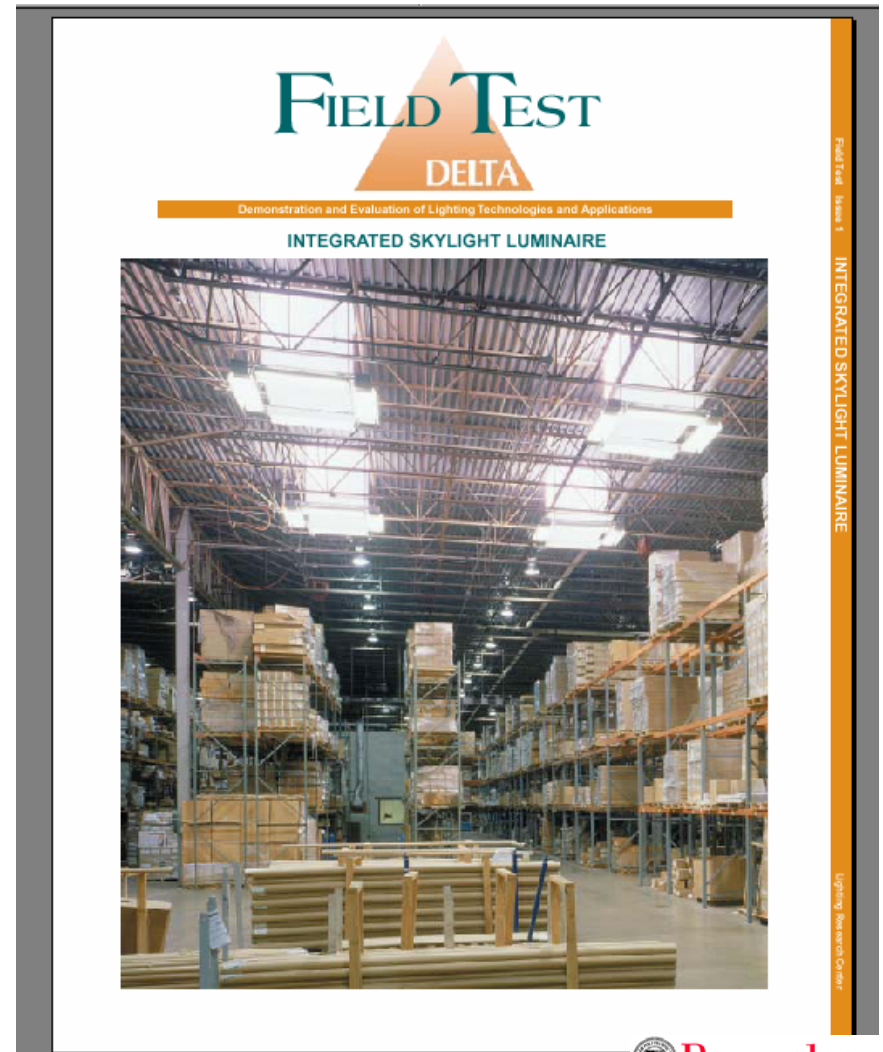


After — Daytime with ISL electric lighting off



Field Test DELTAs

- Integrated skylight luminaire (January 2003)
- Occupancy sensing staircase lighting (Fall 2003)
- Photovoltaic pole light (Winter 2003)



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- Field Test DELTA (Design and Evaluation of Lighting Technologies and Applications)
- **Ongoing testing (time permitting)**

Ongoing NLPIP Research

- **Instant-start systems**
- Pulse-start metal halide lumen maintenance

Long-term Testing

Linear Systems

■ Previous research

- Focused on Rapid-Start ballasts and starting characteristics
- R_H/R_C emerged from this research and correlated to lamp life
- Now we would like to focus on Instant-Start ballasts and starting and operating characteristics

Long-term Testing

Linear Systems

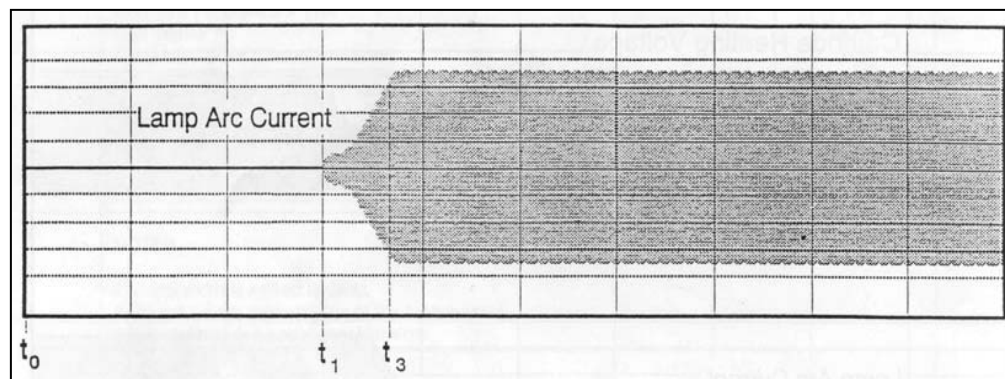
- Linear T8 Instant-Start Fluorescent Systems
 - Four Cycles
 - 5 min on/ 20 min off
 - 1 hr on/ 20 min off
 - 3 hr on/ 20 min off
 - Continuous
 - Six unique systems



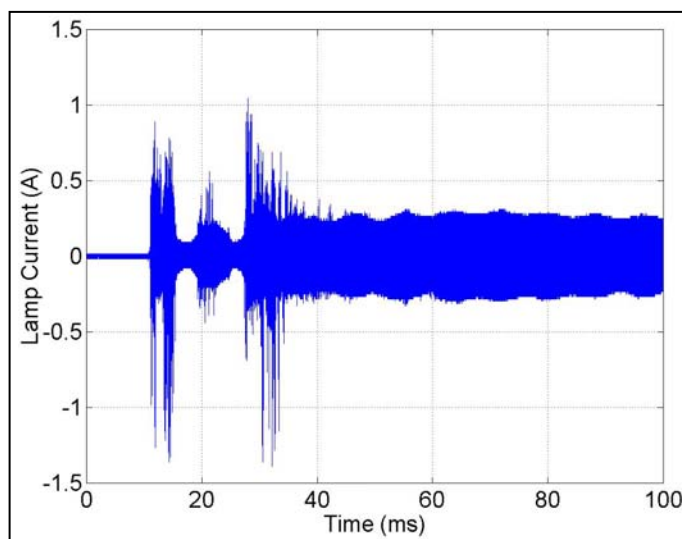
Long-term Testing

Linear Systems

**ANSI illustrated
starting waveform
used to calculate
starting time ($t = t_3 - t_1$)**



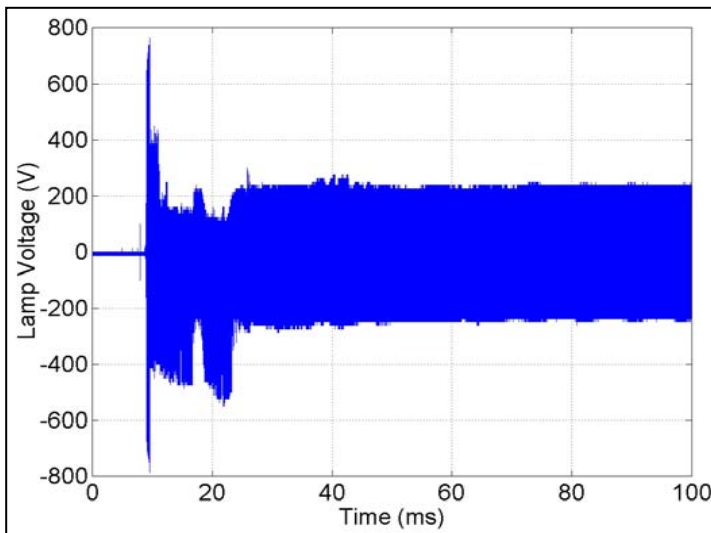
**A sample measured
current waveform**



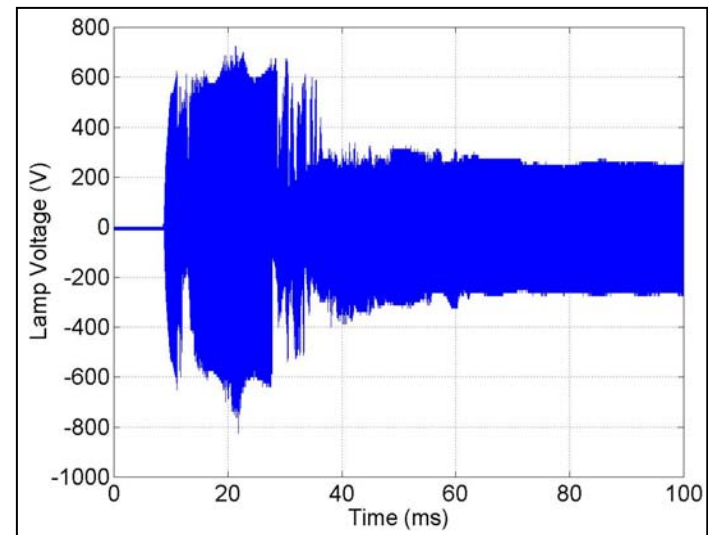
Long-term Testing

Linear Systems

We believe damage during starting is related to the voltage not the current



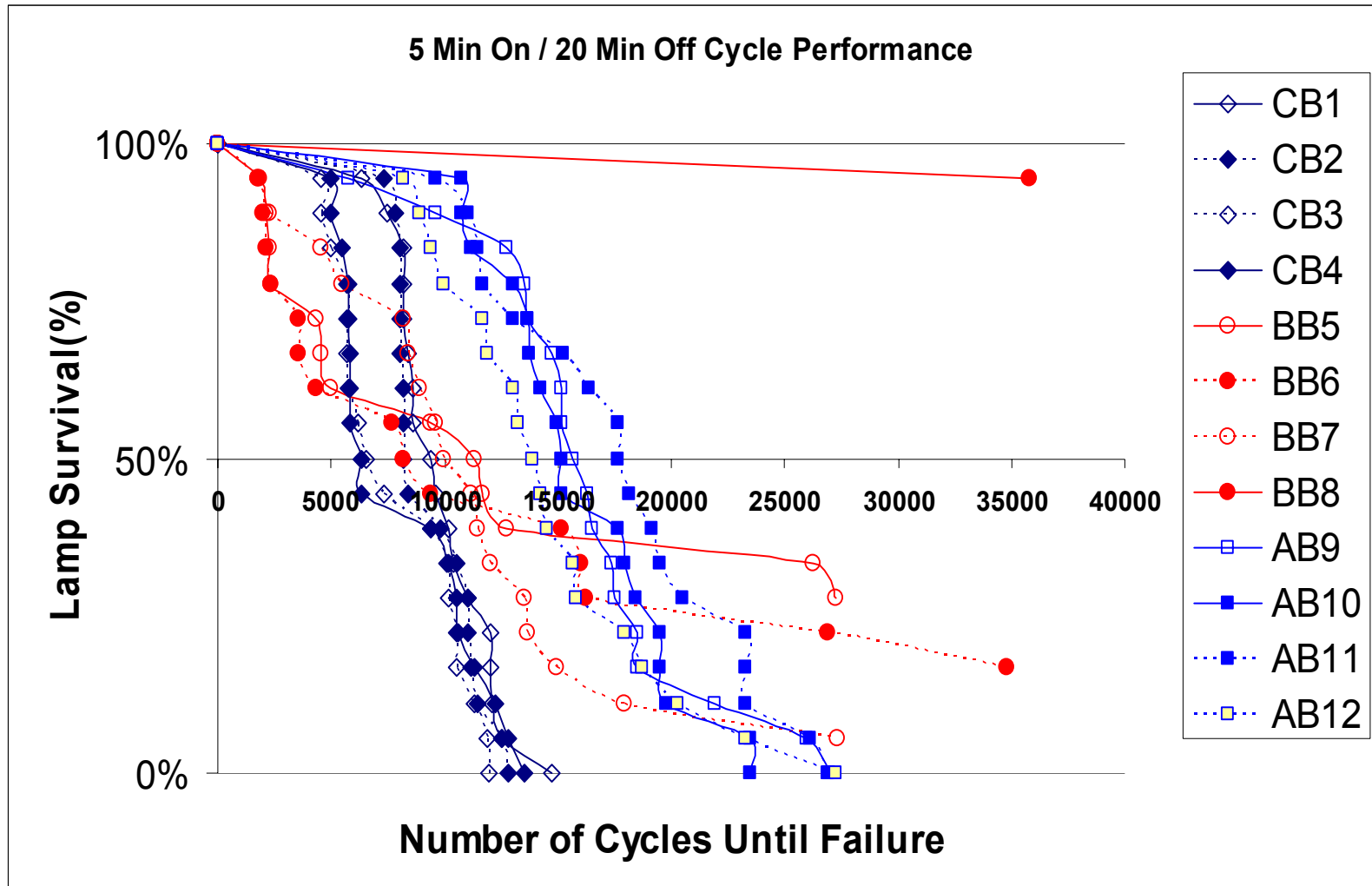
B3 voltage



B9 voltage

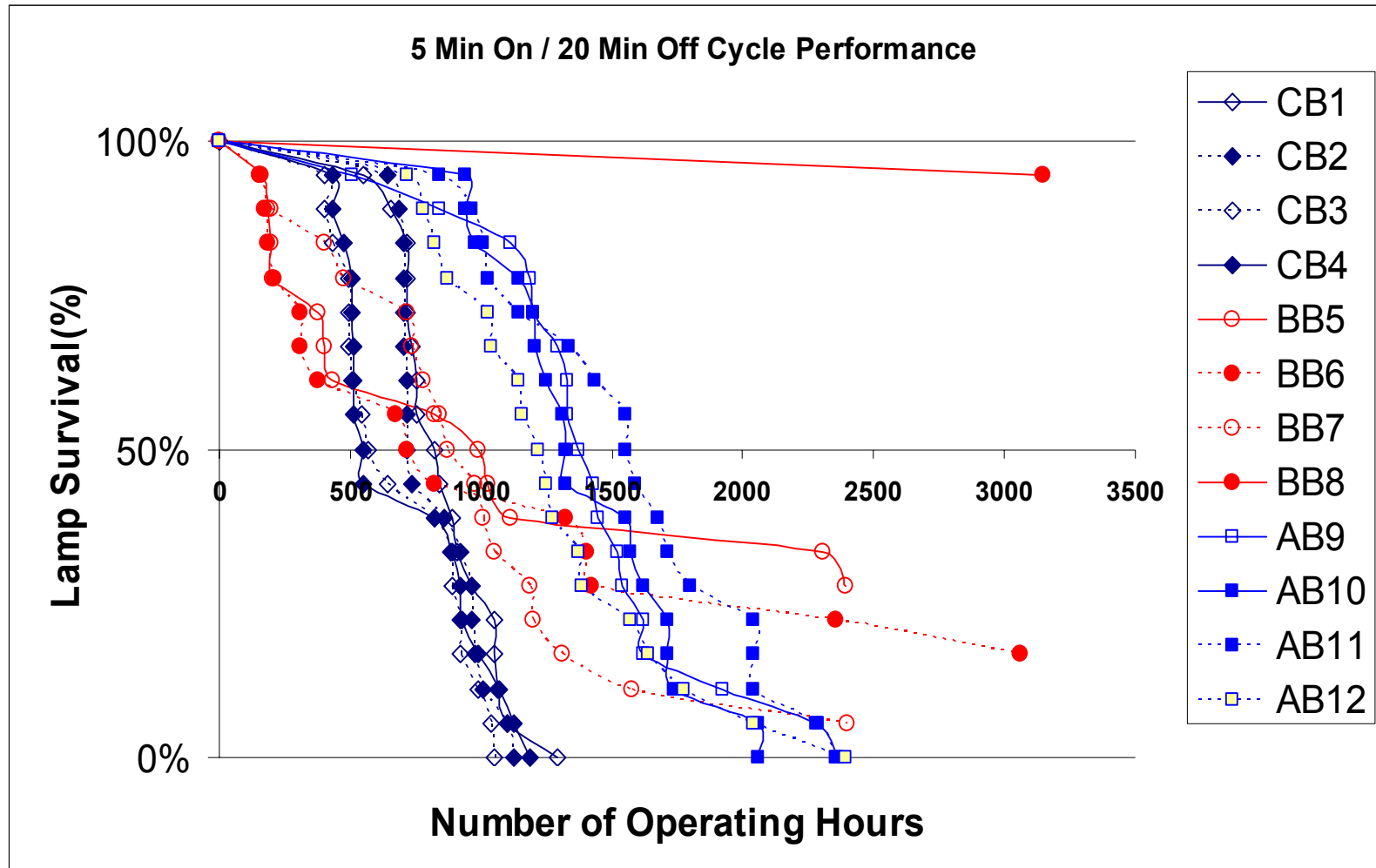
Long-term Testing

Linear Systems



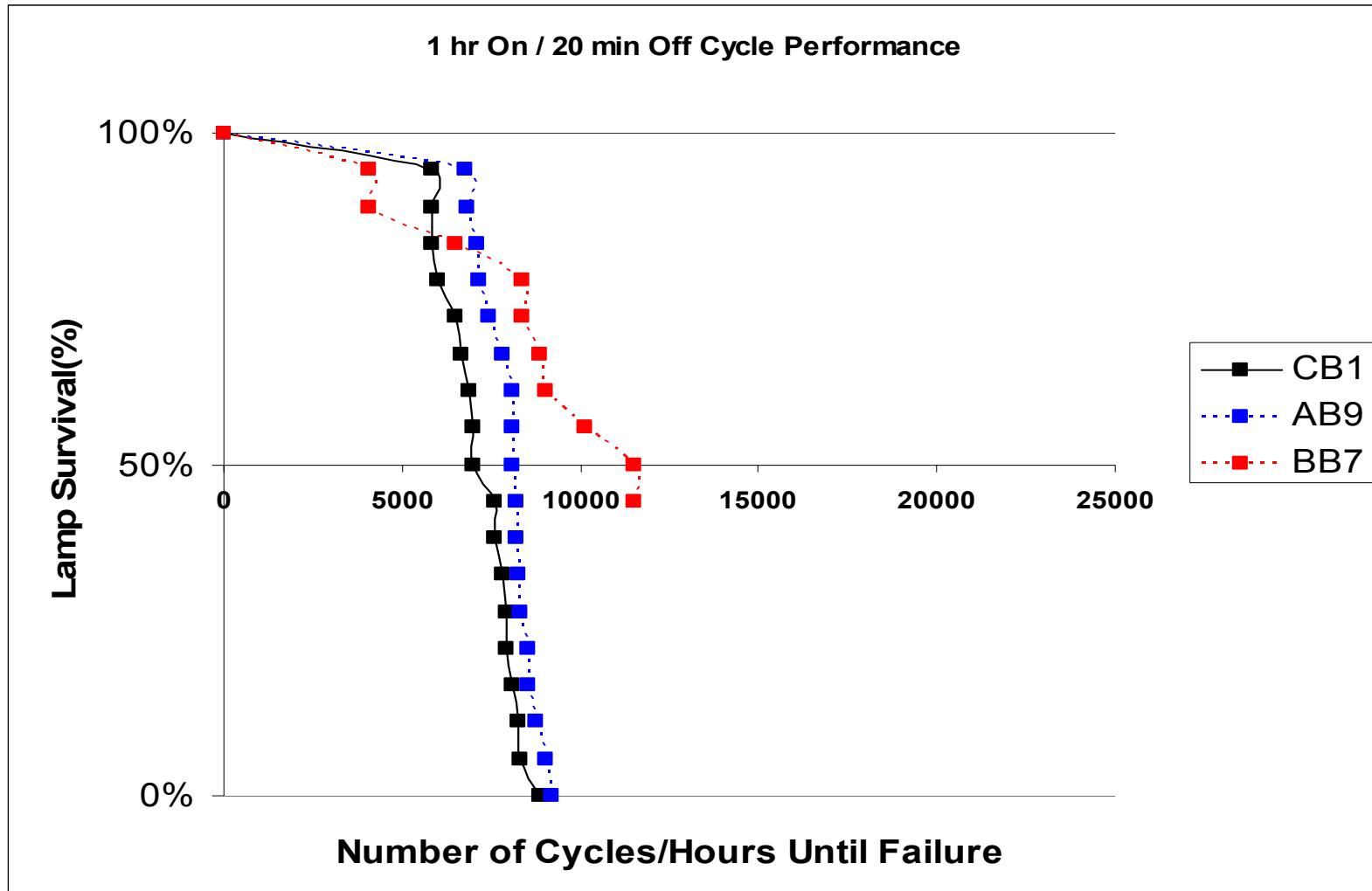
Long-term Testing

Linear Systems



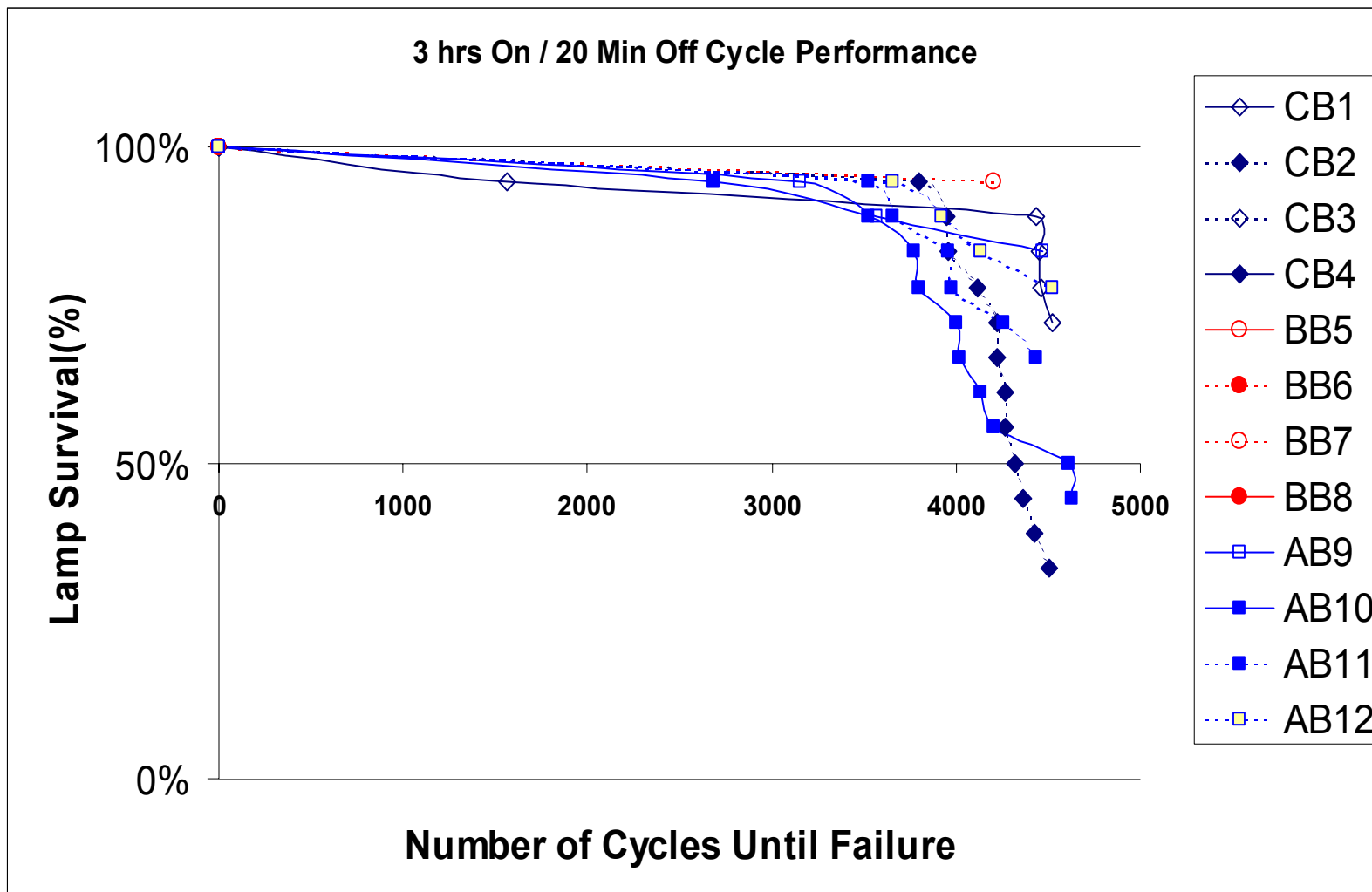
Long-term Testing

Linear Systems



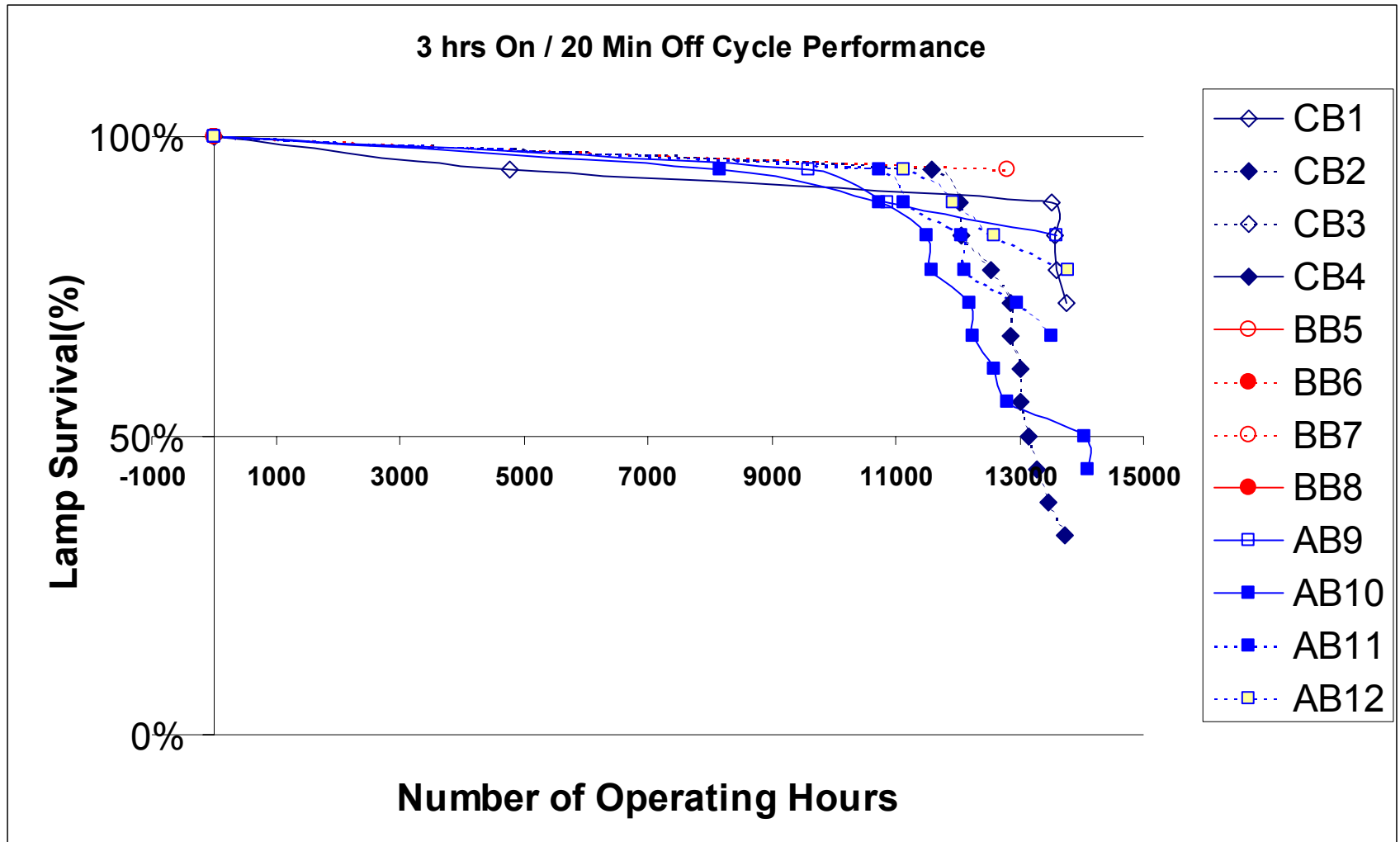
Long-term Testing

Linear Systems



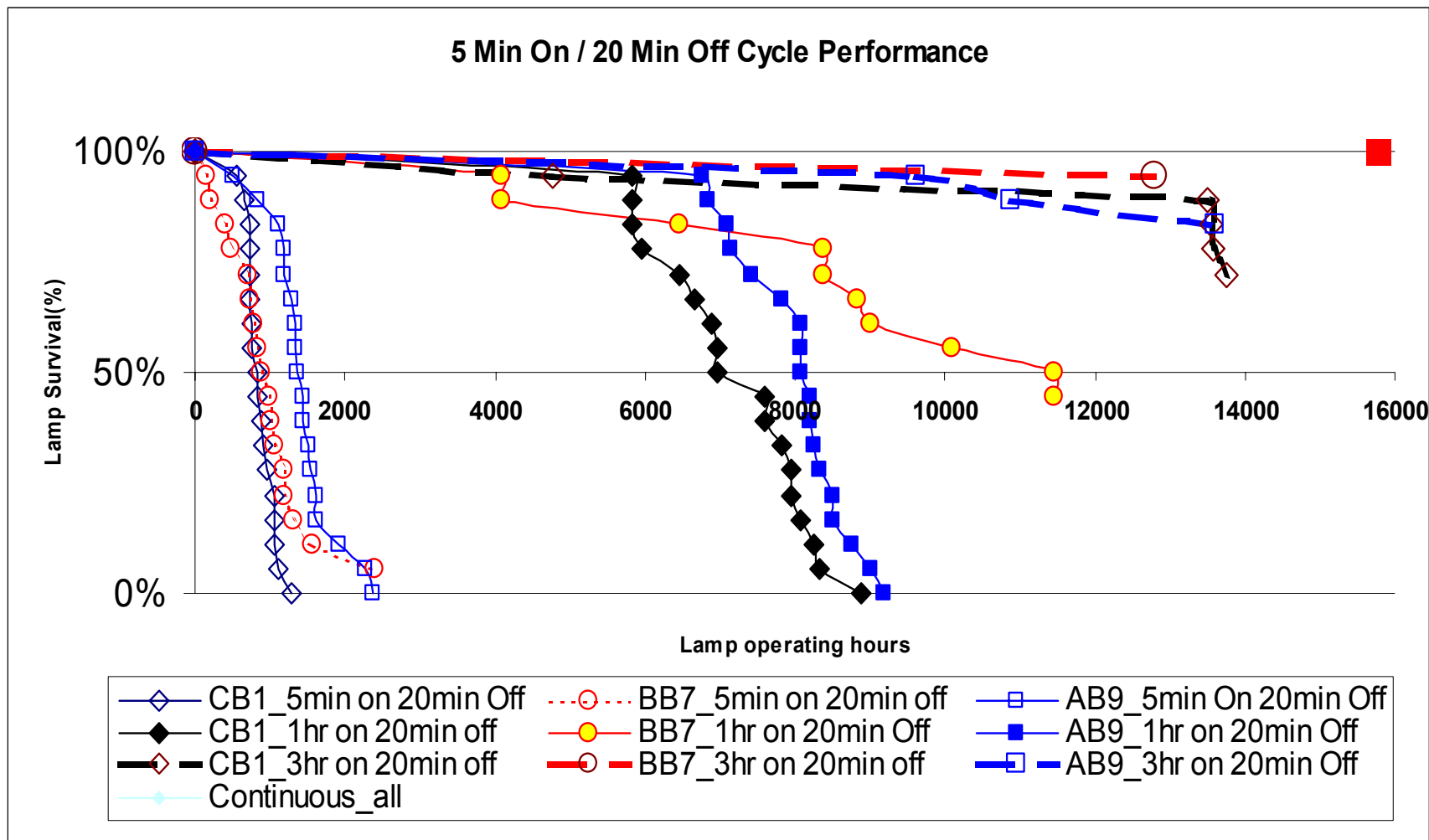
Long-term Testing

Linear Systems



Long-term Testing

Linear Systems



Ongoing NLPIP Research

- Instant-start systems
- **Pulse-start metal halide lumen maintenance**

Pulse Start Metal Halide Lumen Maintenance

Objectives:

- Evaluate standard and pulse start MH lamp initial and mean lumen output
- Validate pulse start MH lamp “energy story” against standard MH lamp

Pulse Start vs. Standard Metal Halide Lamp Manufacturer claims

- 20% increased initial lamp efficacy.
- Superior lumen maintenance
 - (80% vs.65% at 40% rated life for 400w),
 - over 40% higher mean lumens (40% life)
- Up to 50% faster warm-up and restrike time
- Up to 50% increase in life
- Color uniformity: CCT +/-150K vs. +/-300K during life

Plan of Study

■ Lamp Type

| Lamp Type | Specification | Venture | GE | Philips | OSI |
|------------------|---------------|---------|---------|---------|---------|
| Standard 250W | MH250w/U | 6 lamps | 6 lamps | | |
| Pulse Start 250W | MS250w/BU/PS | 6 lamps | 6 lamps | | |
| Standard 400W | MH400W/U | | | 6 lamps | 6 lamps |
| Pulse Start 320W | MS320W/BU/PS | | | 6 lamps | 6 lamps |

■ Ballast Type

- ☐ Life test one Advance CWA ballast, base up
- ☐ Measurement on standard reference reactor ballast, base up

Measurement Variables

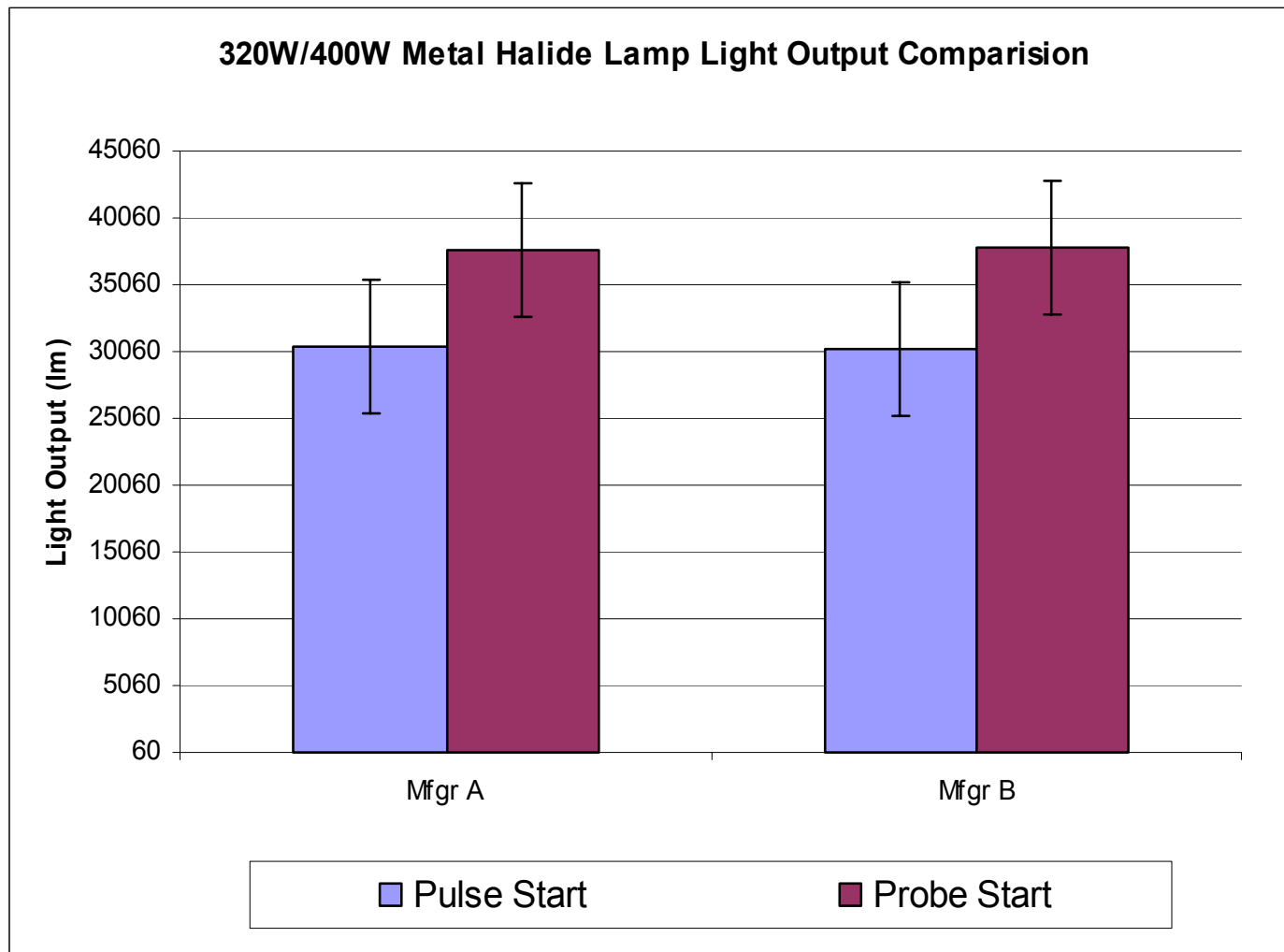
- Initial Test: after 100hr seasoning
 - Initial Lumens
 - System efficacy & lamp efficacy
 - Color variation

- Life Test: (40% rated lamp life):
 - Mean lumen output
 - Life time behavior
 - Color variation

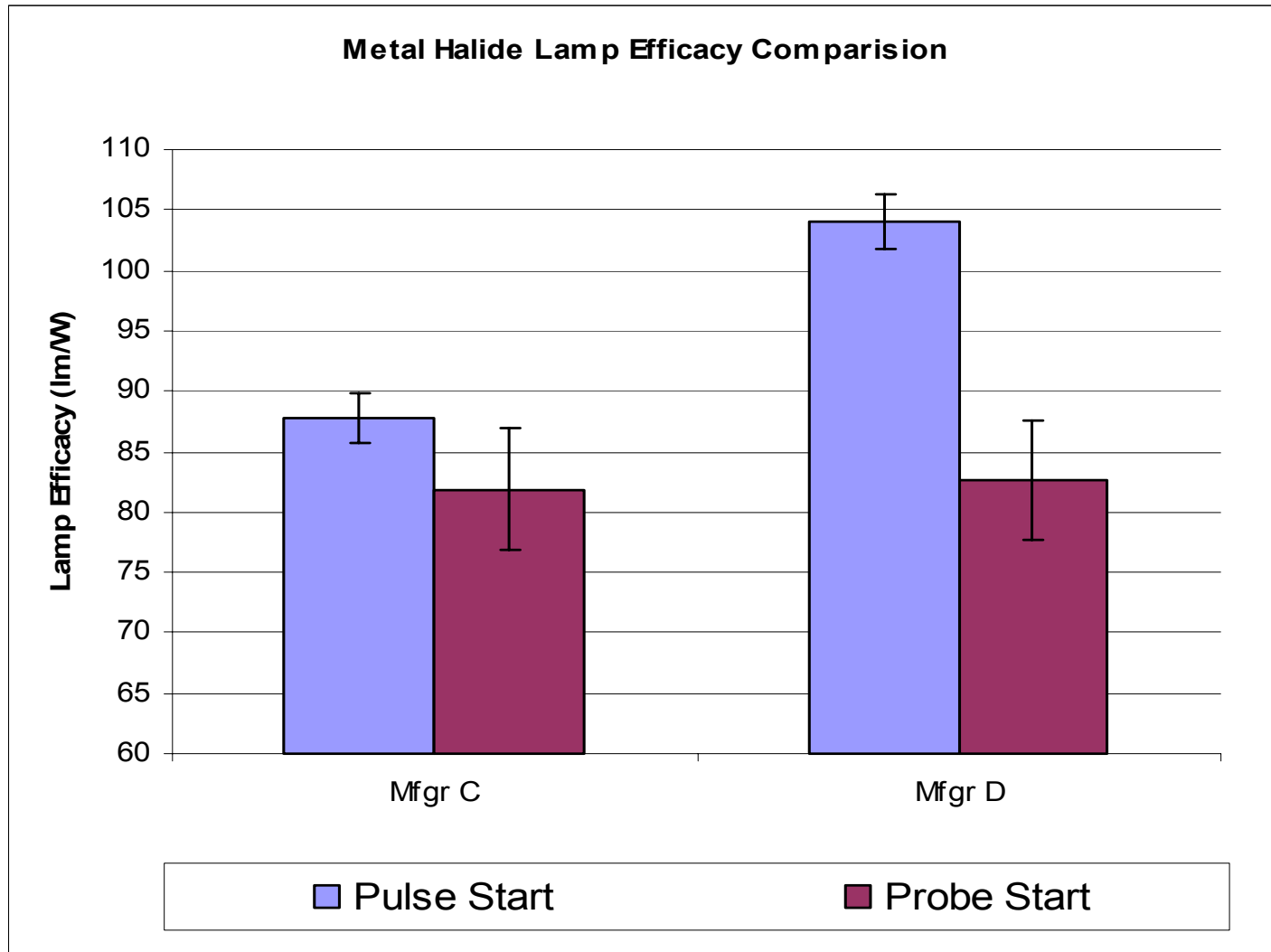
Initial Testing Results

| Test Lamp | Light Output | Efficacy Mean | Efficacy Stdev | CRI Mean | CRI Stdev | CCT Mean | CCT Stdev |
|-------------------------|--------------|---------------|----------------|----------|-----------|----------|-----------|
| Mfgr A 320W Pulse Start | 30368 | 94.9 | 3.0 | 67.3 | 0.5 | 3969 | 257 |
| Mfgr A 400W Probe Start | 37640 | 94.1 | 2.7 | 59.4 | 2.1 | 3897 | 201 |
| Mfgr B 320W Pulse Start | 30240 | 94.5 | 2.1 | 64.8 | 1.8 | 4779 | 158 |
| Mfgr B 400W Probe Start | 37800 | 94.5 | 7.5 | 64.3 | 1.5 | 4509 | 79 |
| Mfgr C 250W Pulse Start | 21950 | 87.8 | 2.0 | 69.6 | 1.0 | 4697 | 505 |
| Mfgr C 250W Probe Start | 20475 | 81.9 | 1.8 | 61.6 | 1.7 | 4382 | 462 |
| Mfgr D 250W Pulse Start | 26000 | 104.0 | 2.2 | 61.7 | 0.5 | 4371 | 237 |
| Mfgr D 250W Probe Start | 20650 | 82.6 | 3.9 | 63.4 | 1.0 | 4459 | 213 |

Initial Light Output Comparison



Initial Efficacy Comparison





Questions?